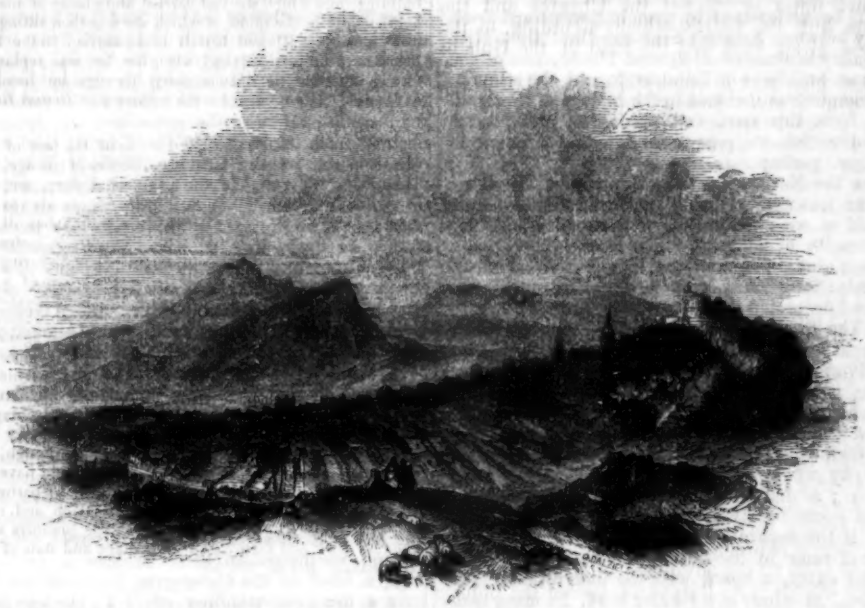


[Edinburgh.]

A FIRST GLANCE AT EDINBURGH.

EDINBURGH, in respect to its topographical features, and without reference to the individual buildings it contains, is perhaps the most remarkable and picturesque city in the British Isles. Nay, there are not wanting writers who place it in the very foremost rank among the cities of the world for natural beauty; and certainly there is here a rare assemblage of most of the beauties which attract attention towards a city. We will endeavour to convey a slight idea of the general appearance of the city, so far as it depends on the undulating surface of its site.

There are four elevated spots, within or immediately contiguous to the town, from whence the eye can see the whole town mapped out beneath. These are the Castle Hill, the Calton Hill, Arthur's Seat, and Salisbury Crags; and these four will serve as points of reference by which the position of the town generally may be estimated. Arthur's Seat forms the most eastern boundary of the city, or rather south-eastern; and from its great height (822 feet) commands a most comprehensive view. At the very summit of this singularly-shaped hill is an isolated block of hard black rock (which probably forms the "seat" of some traditional Arthur); and while sitting on this rock, a visitor can well judge of the position of Edinburgh with respect to the sea. Looking northward, the eye glances over a range of green fields, sloping gracefully down towards the Firth of Forth; then to the Forth, with its steamers and shipping; and beyond to the hills of Fifeshire. To the north-west we look completely over Calton Hill towards a point of the shore higher up the Forth, near the piers at Newhaven and Granton; while between these two directions the eye rests upon the busy seaport of Leith. Directing the attention more westward, we find the entire city of Edinburgh, old and new, spread out before us; presenting at one point the bold rock on which the castle is situated; at another the antiquated and picturesque houses of the old town; at another the finely-situated Heriot's Hospital; and northward of these the magnificent ranges of new streets and squares which give to the New Town an appearance nowhere equalled in London except by Belgrave Square. Southward and eastward a most extensive range of open country comes under view; while in an intermediate direction Dalkeith Palace is just visible. Towards the west and south the near view is partially obstructed by a semicircular ridge called Salisbury Crags, rising to a height of five or six hundred feet, and separated from Arthur's Seat by a deep dell or valley. From the summit of these crags, and from an esplanade or walk at a lower level, another view is obtained, still more magnificent as regards Edinburgh itself, though not so comprehensive as to range.

When we descend from these two elevations, and walk north-westward towards the Calton Hill, we see that a flat low district separates the two; and we shall presently find this low valley a convenient place whence to commence a ramble through the city. Calton Hill rises to a height of three or four hundred feet, being about as much lower than Salisbury Crags as these are lower than Arthur's Seat. It forms the most favourite and admired promenade for the inhabitants of 'Auld Reekie;' being kept open and in good order for the use of all classes without limitation, and having in various parts of its gracefully rounded surface monuments erected to the memory of the good and great, such as Nelson, Playfair, Dugald Stewart, &c. The townsmen have attempted something more ambitious, in the form of a 'National Monument,' which was to be a kind of temple containing monuments of characters who had brought glory or benefit to the country, something on the principle of the Walhalla in Bavaria; but the plan was too gigantic: the means were not adequate to the idea; and twelve columns, supporting nothing, are all that exist to show what was intended—a sad memento of miscalculation. From the western slopes of this hill the topographical features of the city are more distinctly seen than from either of the former; and this has generally been deemed the most favourable point from whence to obtain a view both of the old and of the new town.

The meaning of these terms, 'old' and 'new' town, will be understood by glancing westward from the valley between Arthur's Seat and the Calton Hill. In this valley is situated Holyrood House, one of the easternmost buildings of Edinburgh, and the scene of many a momentous incident in the history of Scotland. Starting from this spot, and proceeding nearly in a westerly direction, we pass through a line of street as picturesque, perhaps, as any in Europe. This line comprises the Nether Bow, the Canongate, the High Street, the Lawnmarket, and the Castle Hill—names which will at once be familiar to the readers of Scott, as the locality of some of his most stirring scenes. The houses along this extended line of street are most remarkable; lofty, many-windowed, gable-fronted, and shaped and decorated with the utmost diversity of character. The dwellers in London have rarely an idea of the great height of these houses: seven, eight, and frequently nine stories or floors rise one above another, becoming generally more and more remarkable the higher they are situated. In Scotland these stories are called 'flats;' and in most cases each 'flat' comprises a distinct set of rooms, cut off from the general staircase by what may perhaps be termed an inner street-door; so that different families—each occupying one 'flat'—are nearly as much secluded from each other as if the separate flats formed distinct houses. In front of some of the houses may be seen, high up above the street, a board with the inscription "Two flats to let," or others of a similar kind. In many cases there is an external staircase from the street to the first floor (as we should term it in England), with a little oddly-shaped shop-window beneath or at one side of it.

This street, or line of street, ascends gradually the whole way from Holyrood House at one end to the Castle at the other; and thus it follows that the Castle itself occupies a lofty position. The Nether Bow is the lower portion of the street; then succeeds the Canongate, perhaps the finest part of the line; and at the Tron Church the High Street commences, terminated by the Lawnmarket, in or near which the once-celebrated Tolbooth stood. On arriving at the Esplanade in front of the Castle, or, still better, on looking from the ramparts of the Castle, we see how remarkably this line of street is situated with respect to the surrounding streets. It is seen to occupy the ridge of a wedge-shaped hill, declining from the Castle to Holyrood House, and also declining on either side laterally; so that this central line of street is bordered on the north and south by a deep valley. Along the northern of these valleys runs a street of poorer houses, called 'North Back of Canongate,' and along the southern another equally poor range, called 'Cowgate,' and 'South Back of Canongate.' Innumerable lateral alleys or courts, called 'Wynds' and 'Closes,' branch out from the central line, and descend to these North and South 'Backs;' and it is in these 'Wynds' that the destitute, the desperate, and the profligate of Edinburgh (for every capital has a large number such) reside. Nothing to be met with in St. Giles's can exceed the filth and squalor of these places; yet so singular is their situation, that they do not offend the eye of a passer-by, unless he look somewhat closely; for the openings into these Wynds from the Canongate and High Street are seldom above three or four feet wide, while the Wynds themselves lie in the deep hollows or valleys to which we have alluded.

When we have passed to the western end of the Cowgate, the large area of the 'Grassmarket' begins; and from this the West Bow leads up a steep to the Lawnmarket, thus opening a connection between the central ridge and the southern valley. That portion of the city which lies south of the Cowgate is nearly on a level with the central Canongate, so that the Cowgate is really in a valley or ravine, and has narrow courts branching up to the north and south from it. This relative position has given rise to an arrangement which constitutes one among the many remarkable features of Edinburgh. As many of the public buildings are in and near the great central thoroughfare leading from Holyrood to the Castle; and as many others—such as the College, Heriot's Hospital, the Greyfriars' Church, Watson's Hospital, &c., are situated on the southern hill; it was long felt as an inconvenience that the approach from the former to the latter should be made by descending the narrow Wynds to the Cowgate, and thence ascending again. To obviate this, two very fine bridges or viaducts have been constructed, called 'South Bridge' and 'George IV.'s Bridge,' which span over the Cowgate at such a height that the roofs of six-storied houses in the Cowgate are seen far beneath the level of the roadway of these bridges. The view of this apparently-sunken street from one of the bridges is most singular: a narrow, close, dirty, pent-up street stretches onward beneath us at such a depth that we can scarcely conceive how intercourse was before maintained between it and the Canongate; and this is in itself sufficient to illustrate the great declivity of the Wynds which branch at right and left from these parallel lines of street. The rising ground southward of these bridges is not quite so high a level as the Canongate, but sufficiently so to give a most commanding effect to Heriot's Hospital and other buildings seen from the north. This southern portion of the city soon begins to exhibit new streets and houses, forming a kind of margin to the old city, and we at length come to the meadows which bound the city in this direction,—the bold fronts of Salisbury Crags and Arthur's Seat bounding the view on the east.

When we come to the western extremity of the central ridge, we find indications, fully as remarkable as those just noticed, of the inequality of the ground on which Edinburgh is built. Although we ascend gradually from Holyrood to the Castle, going westward, yet, when we arrive at the Castle, we find it bounded on the west, north, and south by a precipice almost perpendicular, descending three hundred feet to the level of streets beneath it. All this has a very strange appearance to a pedestrian; for although conscious that he is ascending a steep while walking from Holyrood to the Castle, yet he little expects to meet with such an abrupt and startling termination to his walk. There is an opening leading from the Lawnmarket, down an irregular slope to the low streets visible beneath the Castle; but as there are also handsome streets on a much higher level beyond this depression, another bold and very remarkable viaduct, called the 'New West Approach,' has been built, far above the level of a mass of small streets below, and yet far beneath the level of the hill on which the Castle stands; on one side we look up at the bare and rugged surface of the Castle-rock, soaring to a great elevation; on the other we look down upon about one-fourth of the city.

Transferring our attention now to the district northward of the central ridge, we find features fully as noteworthy in a topographical point of view. The Calton Hill is almost exactly northward of the Canongate, with the 'North Back of Canongate' occupying the line of valley between them; but westward of the Calton Hill there is no similar elevation, the general level being more nearly analogous to that of the Canongate. The 'New Town' of Edinburgh occupies a large area of ground northward of the 'Old Town,' and west and north-west of Calton Hill, but yet the Old Town is separated from the New in a manner

yet more marked than the southern suburbs. There is a deep but broad valley between the two, once called the North Loch, but now occupied partly by a market, partly by shambles, and partly by gardens and nursery-grounds. The descent from the New Town to this central vale is moderate, but from the Old Town it is very considerable. The vale is crossed by two modern erections, one called the North Bridge, in a line with the South Bridge which goes over Cowgate; and the other an immense mound of earth, which originated by forming a depository for dry rubbish, and accumulated till high enough to form a bridge or elevated path across the vale. From the North Bridge a descent of more than a hundred stone steps leads down to the level of the vale, where the busy operations of a large market are being carried on. To a person accustomed to see bridges only as media for crossing rivers or streams, it has a very singular appearance to observe thus, beneath the level of a lofty bridge, all the busy operations incident to the markets of a large city; and while looking westward from this bridge, with the lofty and antiquated houses of the High Street and Lawnmarket, terminated by the bold promontory of the Castle on the left hand, the fine streets and houses of the New Town on the right hand, and the vale between them,—we obtain one of those prospects which illustrate the wide difference between Edinburgh and almost all other towns in the kingdom.

Of the 'New Town,' which bounds the vale on the north, the greater part is formed of fine broad streets, intersecting each other at right angles, and containing handsome residences, many of which are built of stone. The streets have spread out gradually in this direction till they reach a small stream called the Water of Leith; and it is not until viewed either from the Calton Hill or the Castle Hill that the wide extent of these fine streets is appreciated. At one point on the Water of Leith is another instance of that which so frequently occurs in Edinburgh, viz., the crossing by a bridge, from one district of high land to another, over a deep valley; this is at Stockbridge, where a fine bridge crosses not only over the stream, but over a wide stretch of ground on either side of it; and a very beautiful view is hence obtained of a bend of the stream and its adjacent scenery.

The greater part of the New Town is occupied by private residences; but at the eastern end, near the Calton Hill, Princes Street, Waterloo Place, St. Andrew's Square, &c. contain many fine public buildings. Once again have we to allude to a viaduct; for Waterloo Place, a fine street in a line with Princes Street, is carried by very lofty arches over Low Calton and Leith Street, which are low and narrow parts of the Old Town, the roofs of whose houses are very far below the level of the roadway in Waterloo Place. This fine viaduct forms the medium of connection between the New Town and ranges of handsome houses which completely engirdle the Calton Hill near its base.

It will thus be seen that, without describing the buildings, the institutions, or the people of Edinburgh, there is yet in the topographical position of the city much which is very remarkable.

MARBLE PICTURES, AND ARTIFICIAL MARBLE.

THE French artists and artificers seem lately to have paid a good deal of attention to the use of *marble* in the arts, in respect to painting, engraving, encrusting, polishing, &c., and to the preparation of factitious marble. There is a French periodical devoted to useful subjects, under the title of 'Journaldes Connaissances Usuelles,' which has lately contained many articles on this subject; and it may not be uninteresting to notice here briefly a few of the details.

Marble in thin sheets is recommended as a substitute for the ivory tablets used by miniature painters. They vary in length from fifteen to twenty-seven centimetres, in width from twelve to twenty centimetres, and in thickness from five to nine millimetres (a centimetre being equal to about two-fifths of an English inch, and a millimetre to two-fiftieths of an inch). They may be made even thinner than this, but in that case they require to be supported on a thin back of wood or card-board. The slabs are cut from a block of fine-grained marble, and the saw-marks are effaced by grinding with very fine sand; after which they are left in this smooth but unpolished state till wanted to be used, at which time they are polished, either with whetstone in fine powder, or with powder of calcined bones in water; whereby a highly beautiful polish is produced. The artist can give to the marble a higher or lower degree of polish, according to the effects which he wishes to produce, by varying the size of the grains of powder employed. The marble takes the colour better when polished only just before being painted.

The relative advantages of the two substances, ivory and marble, are thus stated:—Although ivory, when just cut and bleached, presents a delicate white, yet it more readily becomes tinged with yellow than good white marble. The light tints in ivory are liable to be changed in tone by any change in the whiteness of the ivory beneath. Ivory can be obtained only in slabs of small dimensions; whereas marble may be obtained of large size, provided means be adopted for strengthening the thin slabs. In hot climates, ivory slabs are exposed to the liability of scaling or peeling; an effect not produced on marble. Ivory is said to be a substance peculiarly liable to the deposition of dew, in a damp state of the atmosphere, whereby stains and discolorations are likely to result; an inconvenience from which marble is exempt. If a slab of ivory be broken, the task of mending it efficiently is almost impracticable; whereas marble slabs have been united, by a cement of lime and white of egg, so effectually as to conceal the joint.

The colours employed for painting on marble are the same as those for miniature painting on ivory, with the addition of a little ox-gall, used to fix the colours and to give a brilliancy of tint. Sometimes colours ground up with wax have been used instead of water-colours, the slab of marble being laid on a bed of hot sand, to give a temperature sufficient to melt the wax. Colours are also used diluted with essence of rosemary. As to the kind of marble employed, the white statuary marble, formed of an aggregation of crystalline grains, is not considered well suited for the purpose, on account of the reflexion of light from the little facettes of the granules. Marble of a more compact and homogeneous texture is preferred; that brought from the Greek islands being deemed most fitting.

Another mode of producing pictorial representations on marble is by a species of aquatint engraving, either in cavity or in relief. The slab of marble being prepared, it is covered with one or more coats of engraver's varnish. When the varnish is dry, the design is sketched on the surface; and the varnish is removed at those parts which correspond with the design. The sketch is then bordered with a little margin of wax; and into the receptacle thus formed is poured a mixture of equal parts of nitric acid and concentrated acetic acid. In a portion of time, more or less long according to circumstances, the acids have corroded the marble in those parts not protected by the varnish. The acid is then poured off, the wax removed, and the

varnish scraped off; after which the marble is polished to any required degree of lustre, leaving an engraving in cavity. By a reverse process, leaving the parts protected which produce the design, the picture would be in relief, like an engraved wood-block.

A third variety of picture or marble is a kind of incrustation or mosaic, combining both the engraving and the painting processes. The slab of marble being selected, the design is sketched on a piece of paper whose under surface is coated with black or red chalk; and this paper being laid on the marble, the design is transferred to the latter by following with a hard pressure all the lines of the design, by means of a suitable instrument. Then, with a hair-pencil, fluid wax is laid on the marble, not only on all the parts exterior to the picture, but in certain parts within the picture itself, as a means of guarding such parts from the action of acid. The marble is only partially polished before this process begins. The acid liquor is then applied to the marble, and allowed to remain till a certain amount of corrosion has been produced, generally to the depth of about one-fortieth of an inch. The acid is applied, drop by drop, from a kind of small cruet, so as to regulate its quantity according to the part of the picture under operation. A period of about three minutes is sufficient to produce the necessary degree of corrosion; and when this is effected, the acid is washed off and the wax removed. An engraving is thus produced, formed of a series of cavities separated by such lines as the wax had enabled the artist to produce; and these cavities are then painted with such colours as correspond to the design, the colours employed being the usual kinds, and the liquid in which they are mixed being either essence of turpentine, oil of gilliflower, fat-oil, or gum-water. The design being thus painted in every part, the colours are allowed to dry, and the marble is then coated with varnish so abundantly as to fill up the cavities, and bring all to the general level of the surface of the marble. The varnish employed is copal, and this is applied in successive coats to the coloured portions by brushes and pencils; each coating being allowed to dry, and being rubbed with polishing-powder, before the next is applied. About five or six coats of varnish bring the cavities to the required level; and the surface is then rubbed for a considerable time with a 'tampon,' or small cushion of linen or cotton covered with silk; the friction being hard at first, and then more gentle, till at length the whole surface presents one general glossy level, the varnish acting like a glass, through which the colours beneath may be seen. In some cases parts of the picture are gilt or silvered, by applying leaf gold or silver, much in the same way as for gilding on wood, a kind of gold-size being employed as the adhesive agent, and the whole being afterwards varnished in the same way as other parts of the picture. This art is called *Neozographie*.

Attention has been paid not only to these modes of painting and engraving on marble, but to the preparation of substitutes for marble, which shall serve either in the fine arts or in the mechanical arts. A factitious marble of this kind is one called *marmarillo*, and is thus described:—Any given quantity of quicklime being prepared, it is sprinkled with one-third of its weight of water, sufficient to make it fall in a white powder. It has been supposed that Vitruvius used these proportions between lime and water in the slaking; and hence Sage, a French writer on the subject, proposes to designate lime so slaked *Roman* lime. Four parts of this Roman lime are mixed with one part of water; and the paste thus made is thrown into moulds, whose form it accordingly takes, and in which it solidifies in about four or five hours. When taken out of the moulds, it hardens gradually, and in about five or six days it is susceptible of receiving a marble-like polish. A medallion of Henri Quatre has been produced in this way, the marmarillo appearing to have a compactness of grain about equal to that of alabaster. It has been suggested that if the water employed in making the paste were saturated with carbonic acid, it might probably render the marmarillo yet harder. A mixture analogous to stucco, and called *marmarillo crétacé* (chalky marmarillo), is thus prepared: three measures of pulverized chalk, two of Roman lime, and a sixth part of a measure of water, are worked up together into a paste, with which ornaments for architectural purposes may be moulded. A mortar of three parts chalk and three parts Roman lime, mixed to a proper consistence with water, is said to form an efficient coating for wood exposed to the action of water.

Another kind of factitious marble is described, differing considerably from that just noticed, and applied to somewhat different purposes. Broken fragments of marble, of glass, and of brick are taken; and after being pounded and sifted very fine, they are mixed together in the proportions of fifty of marble, fifteen of brick, and ten of glass. To these are added fifty parts of hydraulic lime, and the whole are worked up together with water into a paste or plaster. The plaster, on being applied with a trowel to any surface, hardens into a substance capable of being polished like marble; and in order to give the semblance of marble, means are adopted to impart both the ground colour and the colour of the veins, according to the kind of marble about to be imitated. For giving the ground colour the pigments are introduced into the paste itself, and harden with it. For giving the veins, the surface is painted with a pencil, in such forms and tints as correspond with those of the marble to be imitated. A little powdered Venice talc is put into a small linen bag, and sprinkled over the wet colour forming the veins; and this by gentle pressure is made to combine with the colour and with the groundwork. Great care is observed to exclude all *vegetable* colours, as their evanescent qualities would injure the durability of the production: the colours employed are mineral; and the ingredients of the paste are, before using, exposed to a heat sufficient to drive off any vegetable matters which may have combined with them.

Fallacy respecting Fallows.—Now, though a worn-out and tired *animal* requires rest, as well as nourishing food, to recruit his exhausted powers, this cannot be correctly said of the *earth*, which is perpetually reproducing, and only fails in yielding her productions from the exhaustion of those properties which constitute the food of plants, and which are only supplied, in an effective degree and quickly, by manures that contain the required principles. The earth, so far from taking advantage of any kind of rest which a farmer may be disposed to give it, *will* produce something—it will not rest—it will throw up a crop of weeds if left to its own energies; and, therefore, on the same principle that a parent will give his children some useful sources of occupation to prevent them from doing mischief, which he knows they will commit rather than be idle; or as he will cultivate their minds, and sow the seeds of useful knowledge, lest noxious weeds should spring up in their room,—so will the prudent farmer sow something that will produce a profitable return; he will imitate the practice of the gardener, who never dreams of letting his garden rest, because he knows that it will perpetually produce useful plants of one sort or other, and that if he does not cultivate some of them, a rank and luxuriant crop of weeds would be the spontaneous growth of the teeming earth.—*Guide to Service: The Farm Bailiff.*

A DAY AT THE HURLET ALUM-WORKS.

[Hurlet Alum-Mine.]

If the subject of this paper were designated "A Day Underground," it would not inaptly express the main purpose in view; for the many miles of labyrinth whence the alum-ore is procured form by far the most striking and remarkable feature at the Works which are about to engage our notice. But we must somewhat enlarge the scope, so as to follow the crude ore through its manufacturing history.

It will be well at once to anticipate the question, What is Alum? And to give an answer to it. We know that, externally, alum presents the appearance of a whitish crystalline substance; but there is nothing to indicate to the eye that this substance is formed of the three singularly opposite ingredients—sulphuric acid, clay, and potash. Yet such is the case; and we here have one of the many startling facts which chemistry presents. In chemical language, alum is a "sulphate of alumina and potash" (soda or ammonia being sometimes substituted for potash); the alumina is the basis or foundation for all varieties of clay, and derives its name from being an invariable ingredient in alum. Dense and opaque as clay is known to be, even in its pure state of alumina, yet it contributes to the formation of the transparent alum so familiar to us.

These, then, being the three ingredients, the next question naturally would be—Are they met with in a combined state, or do they require to be mixed artificially? Both are true; nay there are even four modes of union; for in some cases crystals of alum are found ready formed in the earth—in others, the three ingredients are met with in the same ore, but not combined into alum—in others, part only of the crude ingredients are found in the ore, and require the addition of the rest—and in others, the whole are combined by artificial means. The subject of alum-making becomes thus a somewhat complex one; but we may perhaps manage to obtain a few general ideas on the matter, without involving the niceties of chemical detail. As respects native alum, it has been found in the form of crystalline needles in some part of the Andes of South America; in the form of a kind of earthy alum, met with in another part of the same chain of mountains; in the form of long thin fibres, having soda instead of potash, and occurring in a third district of the Andes; and in the form of a mineral called *aluminite*, found in some parts of Germany. In all these cases the ingredients are found combined into a state nearly analogous to alum. To go to the opposite extreme, we find that in France—and also at Newcastle—the alum is wholly an artificial product, formed by mixing clay, sulphuric acid, and potash, so as to lead to chemical combination.

The intermediate modes of formation, that is, those which are in part natural and in part artificial, are of more extensive occurrence; in Italy, in Hungary, in Sweden, in Scotland, and in Yorkshire, we find examples. Various ores or earths, called *alum-stone*, *alum-slate*, *slate-clay*, and *bituminous shale*, furnish the main material; and these, treated in various ways, yield the greater part of the alum of commerce. For instance, at Tolfa in Italy alum is made from alum-stone. Nearly four centuries ago a Genoese merchant, who had seen alum-ore in Turkey, observed that at Tolfa trees were growing such as he had seen near the alum-pits in Turkey; and he thence conjectured that alum-ore might exist there. His conjecture was correct, and alum-works were soon established, which have existed ever since. The Tolfa alum-stone contains all the three ingredients, which, after the stone has been roasted, crumbled into powder, and boiled, combine and crystallize in the form of alum, without

the addition of any new ingredient. In Sweden the ore employed (containing a little potash) is alum-slate, which, besides roasting, requires the addition of other ingredients before alum can be formed.

In Yorkshire there are three alum-works. In Scotland there are four, two a little northward of Glasgow and two a little southward. The Yorkshire works, which are near Whitby, originated thus:—Sir Thomas Chaloner, who had an estate near Whitby in the time of Charles I., found alum-ore near the coast, and was desirous of working it; but as there was no one in England at that time who understood the art of making alum, he privately engaged men from Tolfa. The Tolfa works, being very profitable, had from the first belonged to the popes, who, like monopolists generally, tried hard to preserve the whole affair to themselves; the workmen who joined Chaloner were threatened with anathemas and excommunications, but all in vain, for the Whitby works soon became flourishing. Chaloner afterwards had a disagreement with Charles I. respecting the works; for the king, after granting him an exclusive patent, sold half the patent to another party, as a means of procuring money; and this is said to have led ultimately to the active part which Chaloner took against the king in parliament. The Whitby district, where these works are established, is a remarkable one. It consists of precipitous cliffs containing alum-slate, bordering on the sea, and stretching to a distance of about thirty miles along the coast of the German Ocean. The alum-slate is covered with ironstone, sandstone, alluvial soil, and a few other matters; and when these are removed, the rock is broken piecemeal by picks and javelins, roasted, evaporated, and otherwise treated so as to yield alum.

These few details concerning alum and alum-works in other countries will enable us to understand better what meets the eye at the Hurlet works. There is a firm at Glasgow to whom three out of the four Scotch alum-works belong; viz. two near Campsie, and one near Hurlet. Either one of these will suffice to show the general character of all; and through the kindness of the proprietors we are enabled to describe the last named of the three. When the British Association met at Glasgow, in 1840, Dr. Thomson briefly alluded to these works; but rather in reference to the chemical character of the produce than to the arrangement of the works. The Campsie works are situated among the Campsie Hills, a few miles north of Glasgow; while the Hurlet works are a few miles south of Glasgow; both are situated in a partially-exhausted coal district, for reasons which will presently appear.

A pleasant ride of half a dozen miles from Glasgow, or a railway trip to Paisley as part of the distance, brings us to an open part of the country whose green fields give but little indication of the burrowing which has gone on beneath them. On arriving near the village of Hurlet, however, there are here and there streams of smoke visible, which point out the localities of certain alum, iron, and lime-works; and these indicate that the mineral riches beneath are not confined to one kind alone. The country around is undulated with gentle hills and hollows; but still there is a grassy covering which effectually conceals these underlying beds. It is not till we enter the precincts of any of the works that we find the pits which open up a communication between the world above and the world below; and even there we see little from whence a judgment might be formed of the honeycombed condition of the ground beneath: we must grope, in *propriâ personâ*, through miles of shallow, dark, arched passages, regardless alike of water, mud, coal, and alum, before we can rightly understand the "whereabouts" of the mines.

When we get within the boundary of the alum-works, we find an extensive area of ground, occupied in part by buildings where the preparation is conducted, in part by open pits where the ore is steeped, and in part by huge heaps of earthy matter either still burning or lying useless after being burned. It is one consequence of the condition in which the ingredients for alum are found in the ore that a large mass of earthy refuse is separated as an incumbrance; and this refuse is accumulated in enormous ridges and hillocks, until taken away to be used (we believe) for footpaths or in the formation of railroads. There is no large factory, no many-storied building with its various rooms filled with workmen; the buildings being only such as are necessary to enclose the furnaces, the boilers, the tanks, the coolers, and the other vessels required in the process; together with the water-wheels which raise the ore from the pit, and pump liquid from one vessel to another.

In such districts as this, the possession of a mine by no means implies the possession of the ground above it; the two are held by different tenures, and are leased, or may be leased, independently of each other. Nay, not only so; but if the mineral strata beneath comprise more than one kind, each kind may be leased separately, and to a different person from those who lease the rest. Something of this kind occurs at Hurlet. The property is owned by the Earl of Glasgow and other parties, and the surface ground is leased off in the usual way; but as there are four kinds of mineral produce beneath—coal, iron, lime, and alum—the lessee of the surface ground has, as such, no interest in these sources of wealth: other leases are granted, according to the kind of mineral which is to be worked; and thus there may be four or five leases, and as many lessees, co-acting at the same time in one place. For instance, the Hurlet Alum Company rent all the alum found throughout a certain extent of country, but have nothing to do with the iron, the coal, or the lime found in the same pits which yield the alum, those ores being leased to other parties. It thus arises that there may be, and are, different sets of miners at work at one time in the same series of labyrinthine passages, some to collect one kind of material and some another; each party independent of the others, in respect to the contract with the employers, the mode and rate of payment, the kind of tools employed, and the general mode of procedure. This explanation will enable us better to understand what meets the observation when down in the pits.

The alum-ore is drawn up to the surface near the buildings where the subsequent processes are conducted; but the men descend to the mine at the distance of half a mile from that spot, the same shaft serving for the various classes of miners. This shaft is in the middle of a field, and presents to view nothing more than a square opening measuring about six feet each way, guarded by slight wooden palings at the margin, and having ladders of very small steps for the descent. The depth is not very great—insignificant, indeed, when compared with that of the mines whence metallic ores are procured; and hence the descent has nothing about it very fatiguing. But once arrived at the bottom, we are just as much excluded from the light of day and are exposed to the same rough usage as if we were ten times as far beneath the surface. An old coat and cap, a thick pair of boots, a little lamp, and a little courage must prepare us for our groping excursion; and we soon find that not one of these can well be spared.

When we follow our guide from the bottom of the descent into the passages of the mine, the profound darkness has at first a very bewildering effect; for the earthy lining of the passages is so nearly black that it

reflects very little of the light from the small lamps carried in the hand, and thus the lamps seem like so many specks of light set in—nothing. Under foot the soil is rather wet and sloppy, and over head the roof is so low, that a stooping posture is unavoidable. By degrees the eye becomes accustomed to the peculiar gloom of the place; the lamps, which at first only rendered the "darkness visible," now throw a faint glimmer upon a few prominent points, from which we find that we are walking through a low arched passage.

On the occasion when we groped through this mine, we accompanied two of the managers, one of whom had cognizance of and superintendence over the operations for the collection of alum, while the other superintended the coal and lime miners; and we thus had an opportunity of seeing most of the operations going on. After having walked 'in single file' for some considerable distance, we came to a spot where a number of glimmering lights showed that mining operations were being carried on. Some men were seated about on heaps of coal, nearly shrouded in darkness; while others, with bits of lighted candle stuck in their caps, were digging and shovelling coal. One man was preparing a blast; that is, he was placing gunpowder in a cleft of solid coal-rock as a means of riving it. When his operations were completed, all the men retired to a respectful distance, there to remain till the explosion was over; and this interval of a few minutes, though mere matter of course to the miners themselves, is suggestive of some awkward thoughts to those who are new to the subject; for an indefinite expectation of some mischief, which we can neither measure nor guard against, is very apt to arise. However, in the course of a few minutes the fuse was kindled, and the gunpowder exploded; and it was then to be seen that a large mass of coal had been loosened from its bed, upon which the miners immediately set to work.

Having left this spot, we continued our groping through a long series of arched passages; some wet underneath, some dry; some having a railway on the floor for drawing up the 'corves' or baskets of coal from a lower level: some high enough to permit walking in an erect posture, others (and these the greater part) so low as to render a painful stooping posture indispensable; some several feet wide, others wide enough only for one person to pass at a time. These passages branched out from one another at all angles and in all directions, till no one but a practised person could form the least conception of the course we were taking, whether away from or round again towards the entrance. For the most part these passages were deserted coal strata; all the coal having, in the course of years, been removed, except certain portions which were left as pillars to support the roof; and as the stratum of coal thus removed declined at a certain angle in one direction, the void passage acquired the same slope, and thus the transit through the mine is an incline, upward or downward according to the direction.

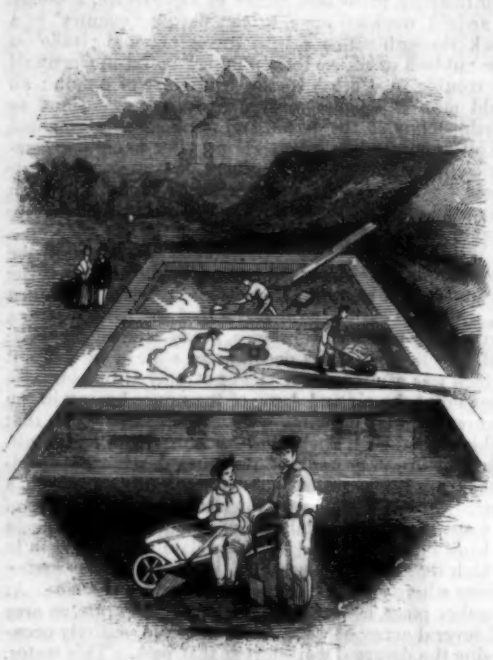
At one part of the mine we came to a spot where a party of lime-miners were at work. The lime was in the form of very hard stone, and the removal of it was severe labour. The number of lights being considerable, and the white stone affording a good reflecting surface, this part of the mine was more visible than any other. The men had the upper part of the body naked, with the exception of the cap which held the bit of lighted candle; and some, in the intervals of work, were seated on low heaps of stone or rubbish, smoking their short pipes. As to their conversation, it was very little more to be understood by a stranger than Gaelic would have been; for the miners' language is full of words not in use elsewhere, or else differently applied. For instance, in the lead-mines of Derbyshire, a 'coffin' is an old working open to the day; a 'country' is a rock through which a vein traverses; and 'trade' is the rubbish or refuse from a mine: again, in Cornwall a 'trouble' is a break in the continuity of a vein; an 'old man' is a place worked in former ages; and so forth—many of the terms and phrases being common to all miners, while others are peculiar to certain localities. Another group of miners, warming some oatmeal 'parritch' over a small fire, and enveloped in the smoke, formed a curious patch in the dusky landscape.

While walking along the arched passages, if the hand were passed over the surface of the roof, or if the head—from a want of proper humility—struck against it, we could easily see that the roof was coated with a crumbling powdery substance, easily scraped from the solid rock. This was a decomposed state of the mineral which was afterwards to yield not only alum, but also copperas; the air and damp of the mines having in the course of years brought to an efflorescent state that which would otherwise have been a hard stony substance. In other parts of the vaulted passages specimens might occasionally be picked up, in which a hard slaty substance was interstratified with layers of a greenish-white crystalline body; while in others again a brownish-black kind of coaly-slate was the form in which the alum-ore presented itself, always occurring *above* where the coal had been, and never below it. At another place, being the lowest part of the mine, an area of several acres of water had collected, entirely occupying the deserted workings at that part. This water, when tasted, was found to be strongly impregnated with the two salts—copperas and alum—resulting from the decomposition of the alum-ore which had dropped into the water, or over which the water had trickled.

After groping in this way for three hours, to a distance of four or five miles through the apparently interminable passages of the mine—some of which belonged to one proprietor, some to another, but all leased (in respect to the alum) to one party—we returned to the entrance; not unwilling to exchange a stooping attitude and a dim glimmer for free movement and the light of day.

Let us next see the processes to which the alum-ore is subjected. In these mines there was originally a stratum of coal, with a stratum of lime above it, and between the two a thin stratum (varying from two to twelve inches in thickness) of ore containing most of the chemical elements for alum. So long as the coal was not worked, the alum probably remained undiscovered, or at least unworked; but when the whole stratum of coal was removed, the slaty stratum above it was laid bare. In this slaty stratum there are, among other elements, sulphur, alumina, and iron; and these, by the long-continued action of air and moisture, lead to the formation of sulphate of alumina and sulphate of iron. But heat will also lead to this transformation; and thus the operations of the alum-works involve two varieties, one for the efflorescent ore, and the other for the stony ore.

Supposing the crumbled ore (which has a greyish colour and a salt taste) to be scraped and collected from the pit, it is put into large open depositories called *steeps*, freely exposed to the air. It is there covered with water partially impregnated with sulphate of iron and alumina, and allowed to remain undisturbed for several hours, during which time the sulphates become dissolved in the water, and the earthy residue subsides. The water, having imbibed the saline matter from the ore, is drawn off to a settling cistern, and the half-spent ore is steeped again and again with fresh water, until all the soluble matter is completely exhausted.



[Steeping-Pits.]

In the cistern the earthy sediment wholly separates, and from thence the liquor is pumped into a series of long arched boilers, so formed as to apply heat to the

[Evaporating Boiler.]

surface of the liquid. By this means a considerable portion of the water is evaporated, and the highly concentrated liquor is then transferred to large coolers, where it remains about a fortnight undisturbed. During this interval a process of crystallization goes on: the liquor contains sulphate of iron (copperas) and sulphate of alumina, and the former of these separates from the latter by gradually crystallizing. Sticks called 'riders' are immersed in the liquid in the coolers, and around these sticks large bundles of beautiful green crystals collect, forming the well-known but absurdly-named 'copperas' of the shops.

When the crystals of copperas have been removed, the remaining liquor is drawn off into an evaporating boiler, in order that the sulphate of alumina may go through the same process as the copperas; and, after boiling to a certain strength, the liquor is drawn off into a cooler. Sulphate of alumina will not crystallize

[Crystallizing Coolers.]

without the addition of potash or some other alkali, and potash is therefore put into the cooler with the liquid, by which, after some days' standing, crystals of alum are produced, those crystals being a sulphate of alumina and potash. After this follow other processes of boiling, evaporating, and crystallizing, for the purpose of purifying the alum—processes which give rise to the distinctions of 'green alum,' 'white alum,' and 'finished alum;' but into these details we need not enter.

When, instead of the efflorescent or powdery ore, the hard or stony ore is used, a preparatory process is necessary. This ore (which in appearance is somewhat midway between slate and stone-coal) contains sulphur, iron, and alumina, like the decomposed ore; but these three elements have not yet been combined into the sulphates of iron and of alumina; and the aid of fire is necessary for this transformation. The ore, after being broken into small pieces, is built up into long ridges, with fuel beneath and air-holes in different parts; and here it is burned as a preparative process.

It will thus be seen that the copperas is an extra prize which the alum-maker obtains from the ore, when the latter has been decomposed by the air; and that the four main processes, varied somewhat in detail, are roasting, steeping, boiling, and crystallizing; and the alum thus made is forthwith ready for use in dyeing, in tanning, and numerous other branches of manufacture.